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RESEARCH MEMORANDUM

RETENTION BEHAVIOR OF ENLISTED TARS IN SURFACE-EXPANSION RATINGS

Monica Hayes

A Division of CNA Hudson Institute

CENTER FOR NAVAL ANALYSES

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This research memorandum investigates factors that affect the material condition of a ship's electrical distribution system (EDS). Deficiencies discovered by the Naval Board of Inspection and Survey (INSURV) are used as a proxy for the material condition of the EDS. Special attention is paid to the effect of ship age, ship size, and Electrician's Mate manning.

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1. Enclosure (1) is forwarded as a matter of possible interest.

2. This Research Memorandum compares the first-term retention behavior of enlisted TARs and regular active-duty personnel in surface-expansion ratings. TARs were found to have a much higher retention rate, but this rate is expected to drop as the TAR surface-expansion program matures.

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RETENTION BEHAVIOR OF ENLISTED TARS IN SURFACE-EXPANSION RATINGS

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ABSTRACT

This research memorandum documents the results of the Surface-Expansion TAR Retention Study. It investigates retention behavior of TAR and regular active-duty personnel in surface-expansion ratings in an effort to discern any significant differences between them. It examines the background characteristics of enlisted TARs in surface-expansion ratings; summarizes their retention decisions; and models first-term TAR and regular active-duty enlisted retention behavior.

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BACKGROUND

The Naval Reserve Force (NRF) consists of ships transferred from the active Navy to the Selected Reserve. Between 1979, when it began, and 1981, these ships were manned with regular active-duty personnel and a Selected Reserve (SELRES) complement that drilled on weekends and for one two-week period each year. In 1981, to meet Congressional direction for the Active/Reserve mix on board NRF ships, career active-duty enlisted reservists responsible for training and administration of the Reserves (TARs) began to replace the regular active-duty enlisted personnel on board these ships. The goal is for TARs to fill 70 percent of the active duty billets in selected ratings.

To man these ships, the traditional TAR ratings that consist primarily of administrative support, medical, and air were expanded in 1981 to include the surface-expansion ratings. Surface-expansion TARs are available from three major sources: recall from SELRES, the TAR Enlistment Programs (TEPs), and conversion from regular USN. TARs in surface-expansion ratings are not eligible for the Selective Reenlistment Bonus (SRB) that their regular active-duty counterparts may receive.[1]

Table 1 presents FY 1986 TAR Enlisted Program Authorizations (EPA) (as of May 1986) versus August 1986 inventories in the surface-expansion ratings. A 29-percent shortfall overall exists in the program, with shortfalls ranging from a low of 11 percent in BTs to a high of 46 percent in ETs. Table 1 also demonstrates that in addition to dealing with FY 1986 shortfalls, authorization increases of 92 percent by FY 1991 present a further obstacle to meeting TAR requirements. Reference [1] presents additional information on future TAR surface-expansion program shortfalls and what policy action may relieve them.

The Surface-Expansion TAR Retention Study investigates retention behavior of TAR and regular active-duty personnel in surface-expansion ratings in an effort to discern any significant differences between the two types of personnel. It examines the background characteristics of enlisted TARs in surface-expansion ratings; summarizes their retention decisions; and models first-term TAR and regular active-duty enlisted retention behavior. This research memorandum documents the results of this study.

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1. The Selective Reenlistment Bonus (SRB) is a one-time rating-specific bonus paid upon an individual's reenlistment for at least three years. It is computed by multiplying a particular rating's SRB multiple (ranging from 0 to 6) by the product of an individual's length of reenlistment in years and monthly pay.

TABLE 1

FY 1986 TAR EPA VERSUS AUGUST 1986 INVENTORY
OF SURFACE-EXPANSION RATINGS

Rating	FY 1986 EPA	August 1986 inventory	Shortfall	Percent shortfall 1986	Percent increase by 1991
Boatswain's mate (BM)	374	215	159	43	75
Electronic technician (ET)	343	184	159	46	78
Machinist mate (MM)	438	373	65	15	62
Engineman (EN)	300	206	94	31	124
Machinery repairman (MR)	138	108	30	22	110
Boiler technician (BT)	313	279	34	11	83
Electrician's mate (EM)	308	174	134	44	104
Interior communications electrician (IC)	127	73	54	43	140
Hull technician (HT)	491	413	78	16	120
Overall total	2,872	2,025	847	29	92

DESCRIPTIVE STATISTICS FOR TARs AND ACTIVE-DUTY COUNTERPARTS

The Data

This section compares TAR and regular active-duty personnel in surface-expansion ratings. The Enlisted Master Tracking File [2], which contains information on retention decisions for enlisted personnel derived from the Enlisted Master Record, was used as a data source for personnel in surface-expansion ratings from October 1980 through March 1986.

TAR demographic information was extracted from CNA's Enlisted Master File, a file compiled from the Enlisted Master Record. The data include 2,113 enlisted personnel identified as TARs serving in surface-expansion ratings in records for October 1980 through March 1986.

Table 2 contains background statistics on surface-expansion TARs. Most are high school graduates, and, in March 1986, 45 percent had less than 73 months of service.

TABLE 2

BACKGROUND STATISTICS ON
TAR SURFACE-EXPANSION RATINGS
(OCTOBER 1980 THROUGH MARCH 1986)

Percent high school graduates	.88
Percent in mental groups I-II	.31
Percent in pay grade E-4 and below	.31[a]
Percent with less than 73 months of service	.45[a]

a. As of March 1986.

Table 3 shows TAR retention decisions made in FY 1981 to March 1986. Possible decisions include reenlistment, extension, and eligible losses. Of the 1,173 decisions made by enlisted TARs in this time frame, 47.4 percent were to reenlist, 34.5 percent were to extend, and 17.7 percent were to leave active duty. This yields an overall 81.9-percent retention rate. This retention rate is artificially high because enlisted TAR personnel can reenlist or extend at any time but can leave only at the end of their obligated service, which most TARs had not reached by March 1986. A TAR could have made more than one decision during this time frame, and each decision was recorded separately.

TABLE 3

TAR DECISIONS:
SURFACE-EXPANSION RATINGS
(FY 1981 TO MARCH 1986)

	Number	Percent
Reenlist	560	47.4
Extend	405	34.5
Loss	208	17.7
Total decisions	1,173	100

First-Term Decision File

The first-term decision file consists of decisions made by enlisted active-duty personnel with less than 73 months of service in pay grades E-3 and above in surface-expansion ratings. Decisions made by TARs prior to fiscal year 1985 were excluded, because due to the 1981 start of the surface-expansion program, TARs were not eligible to leave active duty until 1985. This extract of the Longitudinal Enlisted Master Record excludes Active Mariners who are obligated to go to SELRES after three years of active service and ineligible losses from active duty. The first-term decision file contains 88,105 enlisted regular active and 230 enlisted TAR decisions. The low number of TAR decisions is due to the short existence of the surface-expansion TAR program. TARs make up less than 1 percent of the file. It is possible for TAR and regular active-duty personnel to have made more than one decision during this time. A TAR who extended for 12 months in FY 1985 and then reenlisted for four years in FY 1986 would represent two observations in the first-term decision file.

Table 4 shows background characteristics of TARs and other active-duty personnel in the first-term decision file. TARs in this file have similar characteristics to other active-duty personnel. Table 4 shows that 51.3 percent of the TARs and only 0.3 percent of the other active-duty personnel were on NRF ships or in Shore Intermediate Maintenance Activities (SIMA) when they made a decision.

TABLE 4

FIRST-TERM DECISION FILE:
BACKGROUND CHARACTERISTICS

	Percent of TARs	Percent of other active[a]
High school graduates	88.7	90.6
Pay grade E-3 and E-4	46.5	48.7
White	85.2	87.8
On NRF ship or SIMA	51.3	0.3

a. Excludes Active Mariners.

Table 5 shows a breakdown by rating of personnel. TARs were represented more by BTs and HTs and less by ICs and ETs. As can be seen in table 6, all included TAR decisions were made in FY 1985 and FY 1986. Other active-duty personnel decisions are spread fairly evenly from year to year. The exclusion of earlier TAR decisions was made necessary by the youth of the surface-expansion program. The trends in active-duty retention should be captured by exogenous variables in modeling retention behavior.

TABLE 5

FIRST-TERM DECISION FILE:
RATINGS

Rating	Percent of TARs	Percent of other active
BM	13.9	9.7
ET	5.2	15.6
MM	21.7	25.6
EN	6.5	7.9
MR	5.7	2.4
BT	19.1	9.1
EM	7.4	12.9
IC	0.4	6.1
HT	20.0	10.7

TABLE 6

FIRST-TERM DECISION FILE:
FISCAL YEAR OF DECISION

FY	TAR (percent)	Regular active (percent)
1981	0.0	20.4
1982	0.0	17.1
1983	0.0	17.4
1984	0.0	18.4
1985	67.0	18.6
1986[a]	33.0	8.1

a. Through March 1986.

First-term retention decisions by fiscal year are presented in tables 7 and 8. Reenlistment for non-TARs shot up to 37 percent in 1983, then leveled off to about 34 percent for 1984 through 1986. TARs exhibited an extremely high 57-percent reenlistment rate in 1985, but this dropped to 39.5 percent in 1986 as losses climbed to 22 4 percent. TARs had a much larger extension percentage in both 1985 and 1986. Because TARs are ineligible for the SRB, they have less monetary incentive to choose to reenlist rather than to extend than do non-TARs.

TABLE 7

FIRST-TERM DECISION FILE:
NON-TAR RETENTION DECISIONS
(Fiscal Year-Percentage)

	1981	1982	1983	1984	1985	1986[a]
Reenlist	31.1	30.1	37.0	34.5	34.3	34.1
Extend	19.6	22.7	22.0	24.2	22.9	23.9
Loss	49.3	47.2	41.0	41.3	42.9	42.0

a. Through March 1986.

TABLE 8

FIRST-TERM DECISION FILE:
TAR RETENTION DECISIONS
(Fiscal Year-Percentage)

	1981	1982	1983	1984	1985	1986[a]
Reenlist	--	--	--	--	57.1	39.5
Extend	--	--	--	--	36.4	38.2
Loss	--	--	--	--	6.5	22.4

a. Through March 1986.

MODEL AND ESTIMATION RESULTS

To investigate the differences in characteristics of surface-expansion personnel in the first-term file, their retention propensity was modeled using a multinomial logit model. The multinomial logit model, a nonlinear specification, uses maximum likelihood techniques to calculate the probability that a decision maker will choose a particular alternative from a given set of alternatives. In this case, the alternatives are to reenlist, to extend, or to leave active duty.

An individual chooses the alternative that maximizes his utility. Here the decision is assumed to be a function of the following attributes of the individual and the particular alternative:

$$Decision = f(race, education, paygrade, unemployment\ rate, bonus, military/civilian\ pay, rating, type\ of\ duty). \quad (1)$$

Assuming a logistic distribution for random errors affecting utilities implies that the probability that an individual will choose alternative i is:

$$P_i = \frac{e^{x\beta_i}}{e^{x\beta_0} + e^{x\beta_1} + e^{x\beta_2}}, \quad (2)$$

where $\underline{x}$ is a vector of attributes of the individual and β_i is a vector of estimated coefficients for the ith alternative.

In this model, the assumption is made that TARs will behave in the same manner as regular active-duty enlistees. Coefficients on all variables are assumed to be the same for TARs and regular USN; however, being a TAR is expected to shift equation 2. This assumption was

necessary, because at the time of this study, few years of data on surface-expansion TARs existed. TARs in these ratings are similar to regular active-duty enlistees except TARs do not receive any SRB and they spend more time in homeport. These differences were considered in choosing appropriate variables for this model. (The appendix describes the model and the estimated equations and coefficients.)

The model estimates the mean probability of reenlisting as 33.7 percent, the mean probability of extending as 21.2 percent, and the mean probability of leaving active duty as 45.1 percent. These probabilities represent the likelihood of each alternative, given that a hypothetical individual's set of characteristics were at the group's mean value, which is presented as a basis for comparison. Variable definitions are shown in table 9. Mean values are shown in table 10.

Table 11 presents partial effects (i.e., the effect on probability of a one-level change in a variable holding all others constant at their mean values) of the continuous variables in the first-term decision file.[1]

The entries in table 11 for SRBMULT indicate that a one-level increase in the SRB multiple would decrease the probability of leaving active duty by 1.3 percentage points, decrease the probability of extending by 1.0 percentage points, and increase the probability of reenlisting by 2.3 percentage points. TARs, at present, do not receive any SRBs. Other variable entries in table 11 should be interpreted in a similar manner.[2]

It is also informative to look at the elasticity of reenlistment with respect to pay. A one-level increase in the SRB multiple raises the reenlistment rate by 2.3 percentage points. Translating this into a pay elasticity yields an estimated elasticity of reenlistment with respect to pay of 0.9 (see appendix). This means that a 1-percent increase in military pay would increase the reenlistment rate by 0.9 percent, other things being equal. This elasticity is for only regular enlisted active-duty personnel since TARs do not receive any SRB at this time. As a point of reference, first-term elasticities of the total probability of staying (that includes both extensions and reenlistments) range from 1.12 to 2.72 [5].

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1. These partial effects are calculated using equation A-9 in the appendix.
2. Significance levels for continuous and discrete variable partial effects are not presented due to their computational difficulty. Significance levels for coefficients estimated in the model are presented in the appendix.

TABLE 9

VARIABLE DEFINITIONS

Variable	Definition
DEC	0 if decision to leave active duty 1 if decision to extend 2 if decision to reenlist
WHITE	1 if Caucasian
LTHS	1 if less than high school education
GTHS	1 if greater than high school education
GED	1 if high school equivalency examination
EDDUM	1 if school information missing
AFQT	Score on Armed Forces Qualifying Test
AFQTD	1 if AFQT score missing
SRBMULT	SRB eligible for if regular active 0 for TARs
PG3DUM	1 if paygrade E-3 at decision point
PG5DUM	1 if paygrade E-5 at decision point
PG69DUM	1 if paygrade E-6 to E-9 at decision point
SHIPDUM	1 if receiving seapay at decision point
TAR	1 if TAR
MIL2CIV	Military to civilian pay ratio for decision FY[a]
COHUE	Unemployment rate for decision FY[b]
NRFDUM	1 if on NRF ship or at a SIMA at decision point
BM	
ET	
EN	
MR	
BT	1 if in specified rating at decision point
EM	0 in all implies MM rating
IC	
HT	

a. Military pay was calculated for the median enlistee for first-term personnel. The monthly pay for an E-4 with four years of service [3] was divided into the average civilian monthly manufacturing earning [4].

b. The unemployment rate for experienced wage and salary workers was found in [4].

TABLE 10

MEAN VALUES

Variable	Mean
WHITE	0.878
LTHS	0.093
GTHS	0.022
GED	0.051
AFQT	65.650
AFQTD	0.017
SRBMULT	3.053
PG3DUM	0.075
PG5DUM	0.448
PG69DUM	0.065
SHIPDUM	0.763
TAR	0.003
MIL2CIV	0.553
COHUE	7.214
NRFDUM	0.004
BMD	0.097
ETD	0.156
ENDD	0.079
MRD	0.024
BTD	0.091
EMD	0.129
ICD	0.061
HTD	0.107
EDDUM	0.005

TABLE 11

PARTIAL EFFECTS OF CONTINUOUS VARIABLES ON PROBABILITIES

Variable	Loss	Extend	Reenlist
AFQT	-0.002	0.003	-0.001
SRBMULT	-0.013	-0.010	0.023
MIL2CIV	-0.001	-0.103	0.104
COHUE	0.014	-0.004	-0.010

In this model, discrete random variables take on values of only zero or one, with a value of one signifying possession of the attribute. For discrete variables, the change in the probability of choosing an alternative, given that a certain attribute is possessed, can be estimated by evaluating equation 2 twice. First, set the selected variable in the X vector equal to one and the other variables in the X vector equal to their mean values for the observations when the selected variable equals one. Second, set the selected variable in the X vector equal to zero and the other variables in the X vector equal to their mean values for the observations where the selected variable equals zero. The effect is derived by taking the difference of these two estimated probabilities.

Table 12 presents the effects on probabilities of the discrete variables in the model. The model estimates that being a TAR decreases an individual's probability of leaving active duty by 34.6 percentage points and increases the probability of extending or reenlisting by 15.7 and 18.9 percentage points, respectively. Other variable entries in table 12 should be interpreted in a similar manner.

TABLE 12

PARTIAL EFFECTS ON PROBABILITIES
OF DISCRETE VARIABLES

Variable	Loss	Extend	Reenlist
TAR	-0.346	0.157	0.189
WHITE	0.205	-0.042	-0.163
LTHS	0.047	-0.029	-0.018
GTHS	-0.120	0.057	0.063
GED	-0.009	0.010	0.001
AFQTD	-0.110	-0.075	0.185
PG3DUM	-0.060	0.244	-0.184
PG5DUM	-0.055	-0.130	0.184
PG69DUM	0.238	-0.079	-0.159
SHIPDUM	0.217	-0.192	-0.026
NRFDUM	-0.038	0.117	-0.079
BDM	0.022	0.083	-0.105
ETD	-0.146	0.023	0.123
ENDD	0.041	0.042	-0.084
MRD	0.155	-0.094	-0.061
BTD	0.060	-0.038	-0.022
EMD	0.001	-0.051	0.050
ICD	0.094	-0.057	-0.038
HTD	0.139	-0.031	-0.108
EDDUM	-0.236	0.185	0.051

The strongly negative effect on the probability of leaving active duty indicates TARs are unlikely to choose to leave active duty even though they do not receive any SRB. This result should be viewed with caution, however, because as the TAR surface-expansion program matures, the percentage of first-term participants that will have reached the end of their obligated service (and therefore be eligible to choose to leave active duty) will rise dramatically.

CONCLUSIONS

A comparison of regular first-term active-duty personnel in surface-expansion ratings and first-term TAR personnel shows similar background characteristics, but, although shortages exist, TARs had an 88.3-percent overall retention rate compared to a 55.8-percent rate for regulars. (First-term retention decisions are presented in table 13.) The high TAR retention rate will probably fall as the surface-expansion program matures and more TARs in that program approach the end of their obligated service and are eligible to leave active duty. Due to the 1981 start of the surface-expansion program, TARs were not eligible to leave active duty until 1985.

TABLE 13

FIRST-TERM DECISIONS:
MARCH 1981 TO MARCH 1986

	Loss	Extend	Reenlist
Regular active	44.2	22.4	33.4
TAR	11.2	37.0	51.3

NOTE: TAR decisions are for 1985-1986 only.

The model outlined in the previous section predicts that, if other characteristics are held constant, being a TAR increases the probability that a first-termer will reenlist by 18.9 percentage points and that a first-termer will extend by 15.7 percentage points. On the other hand, being a TAR decreases the probability of leaving active duty by 34.6 percentage points. Note, however, that these results represent only 230 TAR decisions.

The large effect of being a TAR on the probability of choosing to leave should be viewed with caution due to the recent start of the TAR surface-expansion program. These results reflect decisions made in

FY 1985 and half of FY 1986, since the first cohort of TARs were coming to the end of their first terms in that time period. It would be instructive to repeat this modeling when more data on TARs are available.

The first-term model predicts that if an SRB were established for TARs (assuming TARs react like regular first-term personnel), a one-level increase SRB would increase a TAR's probability of reenlisting by 2.3 percentage points. The effect of the initial establishment of an SRB is not as clear. Reference [1] shows that TEP accession goals for surface-expansion ratings have traditionally been met, and that veteran accessions have not. Because regular active-duty personnel crossing over to the TAR program are giving up their SRBs, veteran accessions would probably be most affected by the establishment of a TAR SRB. Reference [1] addresses this issue and projects the effect of limiting TAR SRBs to TARs reenlisting as TARs, in which case veteran accessions would not be affected.

REFERENCES

[1] CNA Research Memorandum 87-159, *Manning Issues in the Surface-Expansion TAR Program*, by Martha E. Shiells, Aug 1987 (27870159)[1]

[2] CNA Research Memorandum 84-1, *CNA User's Guide to the Enlisted Master Records*, by Kevin B. Garvey, May 1984 (27840001)

[3] *Uniform Services Almanac*, edited by Lee E. Scharff and Lt.Col. S. Gordon, USAF RET, 1978 to 1986

[4] *Economic Report to the President*, United States Government Printing Office, Washington, D.C., 1978 to 1986

[5] CNA Research Contribution 476, *Determinants of Navy Reenlistment and Extension Rates*, by Matthew S. Goldberg and John T. Warner, Dec 1982 (02047600)

1. The number in parentheses is a CNA internal control number.

APPENDIX

LOGIT MODEL

APPENDIX

LOGIT MODEL

The logit model is a qualitative choice model that calculates the probability that a decision maker will choose a particular alternative from a given set of alternatives. An individual may choose to extend his enlistment, leave the active Navy, or reenlist for another term in the active Navy. It is assumed that an individual will choose the alternative that maximizes his utility. An individual's utility for the three alternatives is assumed to be given by:

$$U_{Extend} = U(X_E, r_n) \quad \text{(A-1)}$$

$$U_{Reenlist} = U(X_R, r_n) \quad \text{(A-2)}$$

$$U_{Loss} = U(X_L, r_n) , \quad \text{(A-3)}$$

where U is a function and the X_i are all relevant characteristics of alternative i, and the r_n are vectors of all relevant characteristics of the individual.

The elements of the X_i can be partitioned into two subvectors: those observed, denoted by Z_i, and those unobserved. Similarly, partition r_n into observed s_n, and unobserved. Finally, decompose each $U(X_{in}, r_n)$ into two subfunctions, one of observed factors with a vector β of estimated coefficients $V(Z_{in}, s_n, \beta)$, and another with aspects of utility that are unknown, labeled e_{in}. Therefore the utility of the three outcomes for the nth individual are equal to:

$$U_{Extend} = V(Z_{En}, S_n, \beta) + e_{En} \quad \text{(A-4)}$$

$$U_{Reenlist} = V(Z_{Rn}, S_n, \beta) + e_{Rn} \quad \text{(A-5)}$$

$$U_{Loss} = V(Z_{Ln}, S_n, \beta) + e_{Ln} . \quad \text{(A-6)}$$

It is assumed that[1] $V(Z_{jn}, S_n, \beta)$ is of the form $\alpha_i + \beta_{ij}X_j + U_i$, where α_i is the intercept, β_{ij} is a vector of estimated coefficients, X_j is a vector of characteristics corresponding to the β_{ij}, and the u_i are the error terms. Efficient estimates of equations A-4, A-5, and A-6 can be obtained with maximum likelihood techniques using the multinomial logit model in LIMDEP.[2] Estimates for equations A-4, A-5, and A-6 for the model described in the main body of the paper are contained in table A-1.

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1. See Pindyck and Rubinfeld [A-1], pages 301-312.
2. FORTRAN IV Program [A-2].

TABLE A-1

ESTIMATES OF EQUATIONS A-4 AND A-5[a]

Variable	Mean	Coefficient (equation A-4)	Coefficient (equation A-5)
INTERCEPT	1.000	-5.187 (-9.59)	-9.091 (-19.07)
WHITE	0.878	-0.873 (-28.31)	-1.121 (-41.44)
LTHS	0.093	-0.176 (-5.29)	0.257 (9.01)
GTHS	0.022	0.388 (6.12)	0.123 (2.14)
GED	0.051	0.032 (.766)	0.261 (7.07)
AFQT	65.650	0.014 (25.55)	0.004 (8.39)
AFQTD	0.017	0.510 (6.06)	0.808 (11.19)
SRBMULT	3.053	0.011 (1.26)	0.101 (13.89)
PG3DUM	0.075	0.722 (22.88)	-0.356 (-9.18)
PG5DUM	0.448	-0.664 (-30.84)	0.470 (25.64)
PG69DUM	0.065	-1.349 (-31.40)	-1.014 (-25.77)
SHIPDUM	0.763	-1.171 (-54.01)	-0.546 (-26.34)
TAR	0.003	1.990 (8.08)	2.418 (10.20)
MIL2CIV	0.553	10.542 (10.56)	18.315 (20.82)
COHUE	7.214	-0.043 (-5.08)	-0.070 (-9.35)
NRFDUM	0.004	-0.107 (-0.68)	-0.636 (-4.12)
BMD	0.097	0.284 (5.92)	-0.227 (-5.13)
ETD	0.156	0.168 (5.36)	0.166 (6.16)
ENDD	0.079	0.158 (3.22)	-0.285 (-6.41)
MRD	0.024	-0.758 (-10.36)	-0.681 (-12.21)
BTD	0.091	-0.284 (-7.60)	-0.331 (-10.46)
EMD	0.129	-0.395 (-11.98)	-0.164 (-6.09)
ICD	0.061	-0.345 (-7.48)	-0.386 (-10.21)
HTD	0.107	-0.234 (-6.06)	-0.598 (-17.43)
EDDUM	0.005	0.734 (5.55)	0.250 (1.89)

a. Coefficients for equation A-6 normalized to zero. The t-statistics appear in parentheses.

When each of the random errors, e_E, e_R, e_L, is independently and identically distributed in accordance with the extreme value distribution, it can be shown[1] that the probability that decision maker n will chose alternative i is:

$$P_{in} = \frac{\exp(V(Z_{in}, S_n, \beta))}{\sum_j \exp(V(Z_{jn}, S_n, \beta))}, \qquad \text{(A-7)}$$

1. See Train [A-3], pages 15-55.

where j indexes the alternatives.

Equation A-7, the probability of an individual making choice i, can then be written as:

$$P_i = \frac{e^{X\beta_i}}{e^{X\beta_0} + e^{X\beta_1} + e^{X\beta_2}} . \qquad \text{(A-8)}$$

The mean probability of choosing alternative i is calculated by evaluating the vector of characteristics X at their means.

The coefficients obtained in equations A-4, A-5, and A-6 are not informative alone. To see the response of P_i $(i = 0, 1, 2)$ to a change X, the partial derivative of equation A-8 with respect to each continuous X must be taken.

$$\frac{\partial P_i}{\partial X} = \frac{\left(e^{\beta_0 X} + e^{\beta_1 X} + e^{\beta_2 X}\right)\beta_i e^{\beta_i X} - e^{\beta_i X}\left(\beta_0 e^{\beta_0 X} + \beta_1 e^{\beta_1 X} + \beta_2 e^{\beta_2 X}\right)}{\left(e^{\beta_0 X} + e^{\beta_1 X} + e^{\beta_2 X}\right)2} . \qquad \text{(A-9)}$$

For the discrete variables, the partial effect is derived by evaluating equation A-8 at both values of the variable. The other variables in the $\underline{X}$ vector in equation A-8 are set equal to their mean value for observations for each value of the variable. The difference between these two estimates of equation A-8 gives the partial effect of that characteristic.

Elasticities

Responsiveness can also be measured by elasticities rather than derivatives since elasticities are normalized for the variable's unit of measurement. An elasticity is the percentage change in one variable associated with a percentage change in another variable. The elasticity of reenlistment with respect to military pay may be defined as:[1]

$$E_{R,P} = \frac{\% \text{ change in } P_R}{\% \text{ change in } \overline{pay}} , \qquad \text{(A-10)}$$

where $\overline{pay}$ and P_R denoted the mean military pay and mean probability of reenlisting, respectively.

Equation A-9 estimates the partial effect of a one-level change in the SRB multiple on reenlistment rather than the effect of a one-level change in military pay on reenlistment. In order to calculate the

1. See [A-1], page 91.

elasticity of reenlistment with respect to military pay, a one-level change in the SRB multiple is translated into a percentage pay change. The partial effect of a one-level change in the SRB multiple is then interpreted as an equivalent change in the mean probability of reenlisting. The elasticity of reenlisting with respect to military pay is then computed by dividing the change in the mean probability of reenlistment by the percentage pay change.

REFERENCES

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[A-3] Kenneth Train. *Qualitative Choice Analysis.* London: MIT Press, 1986